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Catch assessment of indigenous and exotic carp species of Nasti baor

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Abstract
An investigation on length-weight relationship, length-frequency distribution, catch per unit of effort (CPUE) and stocking and harvesting status of three Indian major carps: rohu *Labeo rohita*, catla *Catla catla* and mrigal *Cirrhinus mrigala* and three exotic carps: silver carp *Hypophthalmichthys molitrix*, grass carp *Ctenopharyngodon idella*) and common carp *Cyprinus carpio* was carried out in Nasti baor (oxbow lake) for the harvesting season from August to December 1995.

The length-weight relationship for six carp species was established for the harvesting months of November and December 1995. The b values for different species respectively for the months of November and December were 2.95 and 2.58 for ruhu, 3.06 and 2.98 for catla, 2.84 and 2.90 for mrigal, 2.75 and 2.60 for silver carp, 2.51 and 1.97 for grass carp and 2.38 and 2.50 for common carp. In CPUE study, the CPUE was 0.58 kg/ha/hr while the catch per gear was 0.08 kg/ha/hr/purse-seine. The recovery percentage of mrigal was highest (63.57%) and it was lowest (16.81%) in case of silver carp. The density of submerged macrophytes (*Hydrilla, Utricularia, Ceratophyllum* and *Vallisneria*) was highest (4.39 kg/sqm) in November and was lowest (0.76 kg/sqm) in September.

Key words : Carps, Catch per unit effort, Macrophytes, Oxbow lake

Introduction

An oxbow lake (local names: *baor*) is a dead river loop cut-off when the river changed its course (Hasan *et al.* 1998b). A baor normally is still part of the floodplain of the river, to which it is connected by inlets and outlets. Baors are not very deep and the rooted vegetations are very common feature of a baor. Fish culture in baors is a practice by which an open water fisheries is converted by screening the inlets and outlets into a culture-based fisheries (Middendorp *et al.* 1996). All the baors in Bangladesh are situated in the moribund delta of the Ganges in southwestern Bangladesh. There are approximately 600 baors in southwestern Bangladesh with an estimated combined water area of 5448 ha (Hasan 1990).

The management situation in the baors are neither strictly comparable to those in the truly open water environment of the rivers and natural depression *(beels)* where the fishery is a 'capture fishery' (BCAS, 1989), nor to the completely controlled closed water system of a pond. A baor is a potential area of fish production and a source of income generations of fishers. The Government of Bangladesh had completed a Pilot

Project for the development of baor fishery with the financial support of World Bank during 1978-1985. Under this pilot project six carp fingerling under direct management of Department of fisheries (DOF). In 1991, second phase of Oxbow Lakes Project (Oxbow Lakes Small Scale Fishermen Project Phase II) was initiated by the DOF with financial support from International Fund for Agricultural Development (IFAD) and with technical assistance from Danish International Development Agency (Danida). Further twenty two baors located in five districts (Jessore, Jhenaidah, Chuadanga, Kushtia and Faridpur) of southwesten Bangladesh were brought under culture-based fisheries management through Oxbow Lakes Project (OLP II) (Hasan and Middendorp 1998, Apu and Middendorp 1998). Oxbow lakes are stocked with three major carps (rohu *Labeo rohita;* catla *Catla catla* and mrigal *Cirrhinus mrigala* and three exotic carps: silver carp *Hypophthalmichthys molitrix,* grass carp *Ctenopharyngodon idella* and common carp Cyprinus carpio) (Hasan *et al.* 1998a). Stocking largely takes place during July-October and fishing starts from November and continues up to June. The present study reports the stocking and harvesting status, recovery of stocked six carp species, the length-weight relationship and the catch per unit of effort of six carp species and submerged macrophytes density in one selected baor, Nasti baor.

Materials and methods

The study was conducted in Nasti baor. The baor is situated in Moheshpur thana of Jhenaidah District. The total area of the baor is 66 ha. The average depth of the baor is 2.64 m during winter and 4.32 m during monsoon. The study was conducted from August to December'95.

Data for water quality parameters

Water quality parameters (temperature, Secchi depth, water colour, water depth, p^H, TDS and conductivity) were recorded once a week at three selected sample sites. Water temperature were taken by holding a thermometer under water for 3 minutes to the nearest ^{0}C. Representative water sample was collected by bottom water sampler for the estimation of bottom water temperature. The bottom water sampler was hand made by the authors. The sampler was nothing but a bottle with a cork connected to each other by ropes. The operational technique was very simple. The bottle, shut down with the cork, was dipped under water (with the help of a weight) and loosen the cork with a sudden and forceful pull. The bottle was then filled with bottom water and then pulled out of water quickly.

Secchi depth was measured by lowering the Secchi disk into undisturbed water until it disappears and was recorded to nearest cm. Water colour was also recorded as clear, brown, green etc. as was seen by the naked eye. Water depth was measured with the help of a graduated bamboo pole adjacent to fish landing complex in cm. p^H, TDS (Total dissolved solids) and conductivity were measured by p^H meter, TDS and conductivity meter (M-90 CIBA CORNING, UK) respectively.

Data on macrophyte

By dipping a wooden quadrant (0.25 sqm) at random in aquatic vegetation area a minimum of six samples were collected and lifting all plant within the quadrant were weighed on a spring balance (SALTER 235 65, UK) after species-wise sorting of macrophytes. Data were taken for the period from September to November'95.

Stocking and harvesting data

Stocking and harvesting data of three Indian major carps: rohu *Labeo rohita*, catla Catla catla and mrigal *Cirrhinus mrigala* and three exotic carps: silver carp *Hypophthalmichthys molitrix*, grass carp *Ctenopharyngodon idella* and common carp *Cyprinus carpio* were collected from Baor Record Book prior to the start of the research project for the analysis of stocking and harvesting data of the period of 15 months. Stocking data were recorded for the period from July'94 to September'95 and harvesting data for the period from October'94 to December'95. The stocking data from July to September'95 and the harvesting data during November and December'95 were collected during the present study. Data recorded for stocking analysis were: total weight (kg), total number, no/kg, size range and weight range, mean size and mean weight.

Lenght-weight data

A total 2196 fishes of different species were collected randomly from the catches of fishermen, of which 248 were ruhu, 386 were catla, 243 were mrigal, 1013 were silver carp, 56 were grass carp and 252 were common carp. The total length in nearest cm and weight in nearest gram of individual fish of each species were measured by using a scale and spring balance (SALTER 235 65, UK) respectively. Total length was measured from the tip of the snout to the end of caudal fin squeezed together.

Catch per unit effort data

The catch per unit effort (CPUE) data of six species were collected during fishing time from November and December'95. The data recorded for the calculation of CPUE were type of fishing gear, number of gear used during each fishing, number and weight of total fish harvested in each fishing, number and weight of individual fish species harvested in each fishing, number of fishermen attended in each fishing, time interval between shooting and hauling of each gear, number of shooting in each fishing and number of hours of fishing. Gear inventory for kotchal (purse seine) fishing was carried out by collecting information on no. of gear, manpower, length and width of the gear, stretched mesh size of the gear, diameter of upper and lower rope, number of float used, boat particulars (such as, size, number etc.) Kothcal jal (a seine net), the length of which varied from 64.4-331.2 m, width from 4.6-165.5 m and mesh size varied from 30-120 mm, were used for fishing.

Data analysis

The length and weight data were used to determine the length-weight relationship, regression coefficient (slope), correlation coefficient (r) and intercept. All data were converted to $\log_{10}$ value to have straight line length-weight relationship. The length-weight relationship was determined by using formula given by LeCren (1957).

The condition factor was calculated by the Fulton's condition factor formula : (Balan 1967)

$K = 100W/L^b$

Where, K = condition factor, W = observed body weight (g) of a fish, L = observed total length (cm) of a fish, b = slope or regression coefficient.

The relative condition factor was calculated by the following formula:

$Kn = W/W'$

Where, Kn = relative condition factor, W = observed body weight (g) of a fish, W' = calculated body weight (g) of a fish.

Length frequency distribution analysis were done according to size group for individual fish species for two month period (November-December'95). Percentage frequencies of different species were also determined at the same period.

Age groups were determined from length-frequency data and figure by the estimation of connecting peaks from modal class (Goeden 1978). Different peaks indicate different age groups on the basis of length and weight.

Efficiency of gear and fishermen were estimated from the catch data for two months (November-December'95). Catch per unit effort (kg/da/fm and kg/day/gear) and catch / 100 sqm/hr., catch/ha/kotchal/hr were estimated from catch data. Percentage of total carp harvested were calculated for each month from total catch data.

The recovery percentages of different species and age groups were calculated by using number of fish stocked and number of fish harvested. Production (kg/ha) of individual species for 12 months period (from December'94 to November'95) was calculated from the catch data. Recovery rate was estimated by the following formula:

$$\text{Recovery rate} = \frac{\text{Total no. of fish harvested}}{\text{Total no. of fish stocked}} \times 100$$

All calculation and analysis were done in Compaq Prolinea 4/25 microcomputer using MS Excel 5.0 software. All graphs were drawn by suing Harvard Graphics 3.0.

Results

Water qualities (temperature, Secchi depth, water depth, p^H, conductivity, TDS, water colour) were within the productive range for baor. Temperature ranged from 29 to 17.8 ^{0}C, Secchi depth from 42.7 to 58.3 cm, water depth from 260 to 284 cm, p^H from 6.92 to 7.06, TDS from 134.8 to 143.1 mg/1, and conductivity ranged from 270 to

296.3 µs during September to December'95. The water colour was light green to green.

Density (kg/sqm) of *Hydrilla, Urticularia, Ceratophyllum, Vallisnaria* during September to November'95 were 0.24-0.67, 0.34-1.29, 0.18-1.43, and 0.67-1.00, respectively (Fig. 1). The density (kg/sqm) of submerged macrophytes were high in November (4.29) and low in September (0.75).

Length-weight relationship of three Indian major carps (rohu, catla and mrigal) and three exotic carp species (silver carp, grass carp and common carp) were determined from length-weight data for November and December'95 (Table 1). Regression coefficient "b" of six carp species vgaried between 1.97 and 3.06. The growth of rohu and catla was found isometric, but was allometric in other four species in November. In December, the values of "b" varied from 1.97 to 3.0. The highest value was found in catla and lowest in grass carp. Isometric growth was observed in catla and the growth of other five species was allometric (Table 1).

During these two months period the values of r, K, Kn of different fish were found to range between 0.85-0.95 and 0.83-0.96, 1.20-16.67 and .47-59.3, and 1-1.03 and 1-1.1 respectively (Table 1).

Age groups of different fish species were determined from the length frequency distribution (Fig. 2ab). The estimated age group of catla were I and II, rohu were I, II & III, mrigal I, II & III, silver carp I & II, grass carp I & II, common carp I & II (Fig. 2ab). The total catch (kg) and catch per unit effort (CPUE) (catch/day/fishermen and catch/day/gear, catch/100 sqm/hour and catch/ha/hour/kochal) were calculated.

Length frequency distribution shows that catla attained 36 cm (707.8 g) and 62.5 cm (4433.3 g) during first and third year respectively. Rohu attained 30 cm (308.5 g), 49 cm (1373 g) and 63 cm (1800 g) during first, second and third year respectively. Mrigal attained 31 cm (416.15 g), 51 cm (1307.18 g) and 63.5 cm (1925 g) during first, second and third year respectively. Silver carp attained 36.67 cm (568.7 g) and 58.5 cm (2611.4 g) during first and second year respectively. Grass carp attained 47.5 cm (1255.2 g) and 61 cm (3000 g) during first and second year respectively. But in case of common carp the length and weight recorded were of 34.5 cm and 90.94 g, and 56 cm and 2750 g during first and second year respectively (Fig. 3). The highest production was achieved for common carp (162.6 kg/ha) and lowest was for mrigal (71.7 kg/ha). The highest individual weight was achieved by grass carp (1.49 kg) and lowest by mrigal (0.53 kg). The total production for the 12 months period (December'94-November'95) was 720 kg/ha. The recovery rate of these species were 33.04% for catla, 63.57% for mrigal, 16.81% for silver carp, 40.23% for grass carp and 60.34% for common carp (Fig. 3). But rohu gave an abnormal recovery rate due to unavailability of proper stocking data. The average recovery rate for all species was 39.24%.

Recovery percentage of 0 age group of individual species were calculated during the fishing period of November and December'95. Highest percentage were shown by catla (5.3), followed by common carp 4.7, silver carp 4.5, grass carp 3.4, mrigal 1.8 and rohu 0.24 respectively. Recovery percentage of mixed year class between I and II fish were also calculated. Mrigal showed the highest recovery percentage (49%).

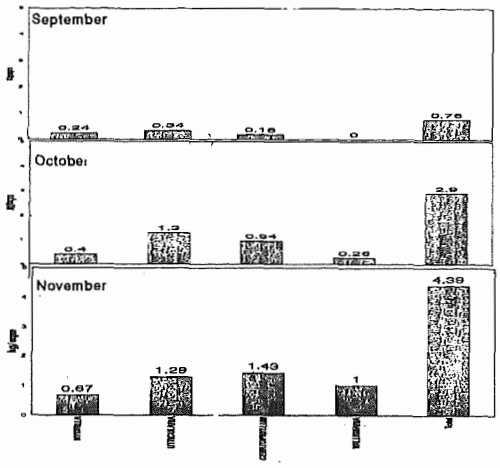

Fig. 1. Density (kg/sqm) of submerged macrophyte in the Nasti baor during September-November'95.

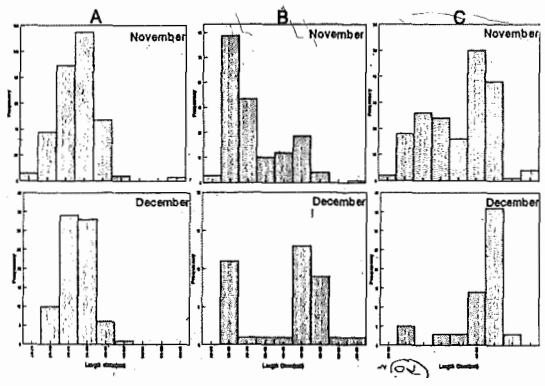

Fig. 2a. Length-frequency distribution of Indian major carps: (A) catla, (B) rohu, (C) mrigal in the catch during November-December'95.

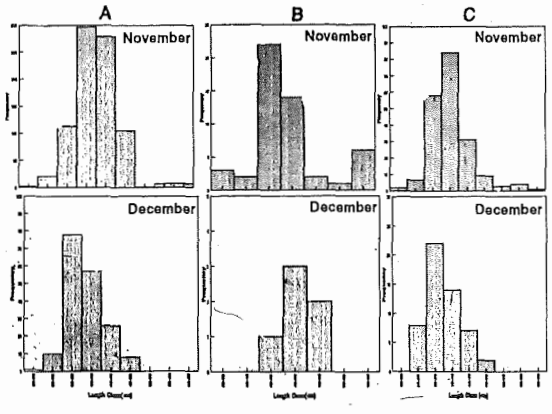

Fig. 2b. Length-frequency distribution of exotic carps: (A) silver carp, (B) grass carp, (C) common carp in the catch during November-December'95.

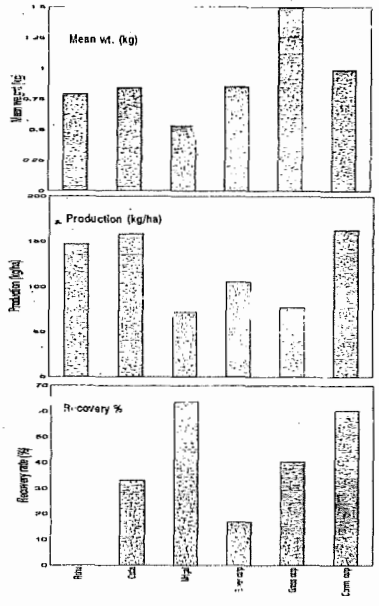

Fig. 3. Mean weight, production and recovery (%) of different carps in Nasti baor.

Table 1. Length-Weight relationship of carps harvested from Nasti baor during the month of November-December'95

Name of the species	Number of samples	Modal length (cm)	Mean total length (cm)	Mean body weight (g)	L-W relationship (LogW = a+b LogTL)	Correlation coefficient (r)	Fulton's condition factor (K)	Relative condition factor (Kn)	Comments on growth
Rohu	210	30	41	629.3	Log W=1.809+2.95 Log TL	0.952	1.6	1	isometric
	(38)*	(29)	(46.22)	(1082.90)	(Log W=-1.232+2.575 Log TL)	(0.957)	(5.999)	(1.106)	(allometric)
Catla	302	37	39.04	774.98	Log W=-1.927+3.059 LogTL	0.925	1.198	1.013	isometric
	(84)	(34)	(37.50)	(658.93)	(Log W=-1.836+2.997 Log TL)	(0.926)	(1.471)	(1.008)	(isometric)
Mrigal	176	50	43.10	959.89	LogW=-1.715+2.841 LogTL	0.946	1.979	1.013	allometric
	(64)	(52)	(44.49)	(1237.19)	(Log W=-1.827+2.902 LogTL)	(0.981)	(1.497)	(1.005)	(isometric)
Silver carp	833	39	42.89	746.20	LogW=-1.56+2.745 LogTL	0.88	2.805	1.018	allometric
	(180)	(33)	(31.71)	(591.67)	(LogW=-1.311+2.603 LogTL)	(0.848)	(4.995)	(1.022)	(allometric)
Grass carp	50	45	47.89	1573.60	Log W=-1.031+2.508 LogTL	0.845	9.6	1.031	allometric
	(6)	(50)	(47.80)	(1283.30)	(Log W=-0.228+1.969 LogTL)	(0.937)	(59.3)	(1.00)	(allometric)
Common carp	199	36	42.35	981.66	LogW=-0.788+2.381 LogTL	0.859	16.669	1.023	allometric
	(53)	(33)	(38.70)	(818.87)	(LogW=-1.006+2.504 LogTL)	(0.834)	(10.04)	(1.018)	(allometric)

L= Length; W= Weight; TL= Total length; a = Intercept; b= Slope

**Figures within parenthesis indicate the values for the month of December.*

Discussion

In length-weight relationship analysis, the regression coefficient "b" of different carp species in two months (November and December'95) were found to be different to some extent. These values stayed within the values of 2 to 4 reported for different carp species in different baors previously studied (Oxbow lakes project II 1994). Iqbal (1995) reported "b" values between 2.55 and 3.35 of these six carp species in Nasti baor during February to April'95. Generally length-weight relationship follows the cube law relationship (Hardjaumula *et al.* 1988), i.e. the value of "b" is equal to 3, it means that the growth of that carp species is isometric and if it is not equal to 3, the growth is assumed to be allometric. It indicates the different growth status of different species in different months. In this respect isometric growth was found in catla in both the months. It may be attributed that in November and December the baor productivity was high, Secchi depth was low and water level was ideal for growth of catla. Isometric growth was found also in rohu in November. It is noticeable that in November isometric growth was found in two species and in December isometric growth was found in only one species. The gradual fall of temperature might have decreased the productivity of baor to some extent. However, growth of fish in baor depends on several factors like stocking ratio, stocking density, ecological conditions of baor and on the quality of fingerlings stocked.

The Fulton's condition factor (K) in case of grass carp and common carp in November and December was abnormal. However, in case of large length range, Fulton, s condition factor can give misleading results (Bagenal 1978). The relative condition factors (Kn) of all species in both the months were more or less same (1.000).

It is generally assumed that modal length represent the probable age group (Goeden 1978, Balan 1967, Burhanuddin *et al.* 1974). In this studies 3 empirical year class was found in rohu and mrigal, 2 in catla, grass carp and common carp. Rohu increased 19.0 cm in the II age and 14 cm III age and mrigal increased 20 cm in II age and 12.5 cm in the III age which showed that growth of fish decreases with the increase in age (Fig. 2ab).

In case of catch per unit of effort, 0.575 kg fish were caught per ha per hour and 0.082 kg fish were per ha per hour per kochal during November which showed a poor catch. This might be due to the increased water depth of baor, which affected the gear efficiency. The poor catch in per unit of effort indicates that kochal is not the only efficient gear for the majority of the species that are stocked. However, in view of the equity and employment issues associated with the fishery, discontinuation of the use of this gear is not suggested.

Recovery percentage of silver carp was comparatively less than those of other species. It can be explained that the stocking was very high resulting high mortality and also resulting an adverse effect on growth. High recovery percentage of mrigal might be due to the combination of several factors such as ecological suitability for the species, suitable stocking rate, relative hardness of the species etc.

There was a mass mortality of carps, specially silver carp, in the Nasti baor during the last half of October'95 which might have happened due to (i) high density of fingerling stocking, (ii) water pollution due to dense jute rotteuing, (iii) wonding of fingerling due to stress during stocking, (iv) depletion of oxygen and increase of TDS and conductivity.

Density (kg/sqm) of submersed macrophyte was high in November, possibly due to decrease in number of grass carp by continuous fishing. Fishing started from this month.

Conclusions

This study highlighted stocking and harvesting status, length-weight relationship, catch assessment of six important carp species (rohu, catla, mrigal, grass carp, common carp and silver carp) in this baor. The study also highlighted the estimation of macrophytes-the major source of food for harvivorous fish species in baors. The result of this type of study will be very much useful to get a sustainable yield from the haor by utilizing the potential food resources.

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